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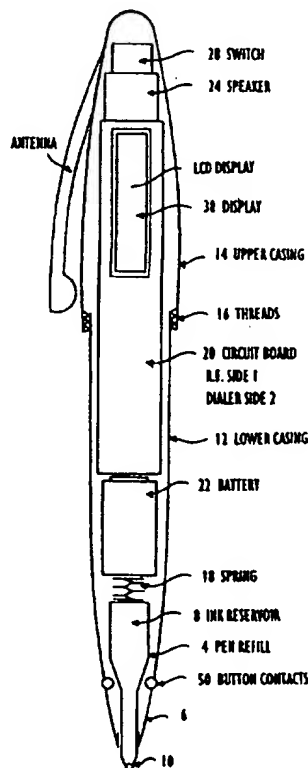
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(54) Title: MULTI-FUNCTION PORTABLE COMMUNICATION DEVICE

(57) Abstract

A multi-function personal communication device is contained in a functional writing instrument. The pen includes a pager (32), a DTMF dialer (34), a microcontroller (30), memory (42), a real-time clock (60), an LCD display (38), batteries (22), and a menu-based interface (40) for utilizing the various functions of the system. A speaker (24) is also located within the housing for notifying the user of scheduled events, incoming pages, and for generating DTMF tones for automatically dialing telephone numbers stored in the memory (42). A switch (26) on the pen enables the user to scroll through the menus and to make selections. The pen can interface with another computer via a recharging/data communications station which engages with contacts (50) on the pen. A pager security system is provided in which the paging decoder includes a disable address and an enable address.



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MULTI-FUNCTION PORTABLE COMMUNICATION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multi-function personal communication device, and more particularly to a functional writing instrument which incorporates a paging device, a DTMF dialer, a telephone directory, a telephone calling card and a disable feature in the event that the multi-functional communication device is stolen or lost.

2. Description of the Related Art

Various types of personal communication devices are known in the art. One such device is a paging device, which has commonly become known as a "beeper." Typically, a pager is contained in a small plastic enclosure with a liquid crystal display visible on the exterior of the enclosure, and is worn on the waist of a user. The pager includes an antenna for receiving paging signals, and a receiver for demodulating the transmitted paging signal. A paging decoder then decodes the transmitted messages. Each pager is programmed to receive only paging signals transmitted by a particular subscriber network and addressed to that pager. If the transmitted message is addressed to a particular pager, the pager will display the transmitted message, which is ordinarily a telephone number.

Another type of personal communications device is the automatic dialer. Such a device is shown, for example, in U.S. Patent No. 4,126,768. In such a device, a telephone number is fed to a DTMF tone

generator which is acoustically coupled to a telephone hand set so as to dial the telephone number. The dialer may include a memory for storing a plurality of telephone numbers which may be selectively dialed by the automatic dialer. Other devices, for example, U.S. Patent No. 4,126,768 and 5,212,721 have combined a pager and a dialer in a manner such that the telephone numbers received by the pager may be communicated to the dialer for automatically dialing the telephone number of the paging party.

Each of these pager and dialer devices tend to be inconvenient to carry since they are ordinarily worn on the user's waist. Cox, U.S. Patent No. 4,763,355 discloses a DTMF dialer which is incorporated into a pen or other writing instrument. A memory, a logic circuit, and a battery are provided within the pen housing to operate the dialing circuitry.

It would be desirable to have a more comprehensive personal communications device which is contained in a writing instrument to provide more functionality to the user. It would also be desirable to have a personal communications device which may be remotely disabled and includes security features.

SUMMARY OF THE INVENTION

The present invention is a multi-function personal communication device which is incorporated into a housing shaped like a writing instrument. The housing has a tip end having an aperture extending therethrough. A writing element is disposed within the housing and extends through the aperture at the tip end.

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A microcontroller is located within the housing and controls the overall system. The microcontroller communicates with a memory means also located within the housing. A display, controllable by the microcontroller, is mounted on the housing so as to be visible on the exterior of the housing. The system includes a paging system having one or more addresses associated therewith. The paging system includes:

- I. an antenna located on or within the pen housing for receiving RF paging signals comprising paging messages, each paging message associated with one or more pager addresses;
- II. a paging receiver for demodulating the RF paging signals received at the antenna; and
- III. a paging decoder for decoding selected paging messages in the demodulated RF paging signals addressed to paging system and transmitting the paging messages to the microcontroller.

A speaker is located within the housing, and the housing includes one or more apertures extending therethrough adjacent to the speaker for enabling sounds generated by the speaker to be audible outside the housing. A DTMF tone generator is also located within the housing and connected to the speaker. The DTMF tone generator is controllable by the microcontroller to generate DTMF tones for automatically dialing telephone numbers. A source of power within the housing providing electrical power to the microcontroller, the paging system, the speaker, the display, the memory means and the DTMF tone generator.

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A switch is located on the housing, preferably on the opposite end of the pen from the tip end. Closure of the switch is detected by the microcontroller and is used to enable a user to accessing a control system, preferably a menu system, to utilize the various personal information functions of the system. These functions include:

- storing paging messages in the memory;
- controllably displaying received paging messages and stored paging messages on the display;
- retrieving messages from the memory for display;
- deleting messages from the memory;
- retrieving a paging message comprising a telephone number from the memory and causing the DTMF tone generator to dial the telephone number;
- storing telephone numbers and other personal messages in the memory;
- retrieving and displaying the telephone numbers and other personal messages;
- retrieving a telephone number from the memory and for causing DTMF tone generator to dial the telephone number;
- storing one or more telephone calling card telephone numbers;
- retrieving the telephone calling card number and causing DTMF tone generator to dial the calling card number; and
- dialing an access number prior to dialing a telephone calling card number.

The source of power in the pen is preferably one or more batteries. At least two electrical contacts are positioned on the exterior of the housing in electrical contact with the batteries. A recharging station is shaped to have the housing at least

partially inserted therein with at least two electrical contacts on the recharging station positioned to engage with the electrical contacts on the housing when the housing is inserted into the recharging station. The recharging station includes a conventional battery charger for recharging the pen batteries.

A data communications line in the pen is connected to at least the microcontroller or the memory. Two or more data communications electrical contacts are positioned on the exterior of the housing connected to the data communications line. The recharging station preferably also includes two or more electrical contacts positioned to engage with the data communications electrical contacts on the housing. Means for enabling data communications with the data communications line in the pen is provided in the recharging station.

The apparatus further comprises a real-time-clock located within the housing and connected to the microcontroller. The menu based control system enables the following further functions:

- time or date stamping paging messages;
- storing scheduling events in the memory; and
- notifying the user of a scheduled event.

A pager security system is provided which may be used in the pen of the invention or any conventional paging system comprising an antenna for receiving RF paging signals comprising paging messages, each paging message associated with one or more pager addresses; a paging receiver for demodulating the RF paging signals received at the antenna; and a paging decoder for decoding selected paging messages in the demodulated RF paging signals addressed to paging system. The paging decoder comprises a disable

address. When a page is received, the paging decoder determines whether the received paging message is addressed to the disable address. If so, the paging decoder or the controller at least partially disables operation of the pager or personal communication device. The paging decoder may also comprise an enable address, with the paging decoder determining if a received paging message is addressed to the enable address and re-enabling operation of the paging system in response to receipt of a paging message addressed to the enable address.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional side view of the personal communication system of the present invention.

FIG. 2 is a block diagram showing the personal communication system of the present invention.

FIG. 3 is a block diagram showing the paging system used in the present invention.

FIG. 4 is a block diagram of a typical microcontroller used in the invention.

FIG. 5 is a block diagram of a typical pager receiver used in the invention.

FIG. 6 is a block diagram of a typical paging decoder used in the invention.

FIG. 7 is a perspective view showing the multi-functional pen of the invention and the recharging/data communications station.

FIG. 8 shows a flow diagram of the operation of the menu system of the invention.

FIG. 9 shows a flow diagram of the system operation for receiving a page.

FIG. 10 shows a flow diagram for operation of the scheduling system on the pen.

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FIG. 11 shows a flow diagram of a security method of the invention.

FIG. 12 shows a flow diagram for operation of the system with an external communication system. (FIGS. 4-6 are copyrighted circuit diagrams of Philips Electronics)

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the present invention is a functional writing instrument which includes a complete personal information system contained within the body 2 of the writing instrument. The writing instrument is preferably a pen, as shown in FIG. 1, but may be any type of writing instrument, i.e. a mechanical pencil. Writing is performed by a pen refill 4 located toward a writing end 6 of the instrument. The refill includes an ink reservoir 8 which is fed to a conventional ball-point 10. Any type of appropriate pen refill may be used, if desired. A spring 18 biases the refill 4 toward the tip end to facilitate writing using the pen. While it is preferred that a functional writing element be included in the present invention, it is readily foreseen that the present invention will operate properly without the functional writing element.

The writing instrument includes a lower casing 12 and an upper casing 14 which are preferably connected by threads 16. In order to change the pen refill 4 or the batteries (discussed below), the lower and upper casings 12 and 14 are screwed apart to expose the interior of the instrument. Lower and upper casings 12 and 14 are preferably constructed of a thermoplastic.

Included within the writing instrument is a circuit board 20 containing a radio pager, a telephone number memory, a display controller, an

automatic telephone dialer, a microprocessor controller and an interface to a personal computer. Each of these will be discussed in detail below. One or more batteries 22 are located above the pen refill 4 to provide power to the various electronic components of the device. The main interface to the user is via liquid crystal display (LCD) 38. LCD display 38 is preferably a conventional display which includes a matrix capable of displaying 12 or more characters. Of course, a longer or multi-line display could be used, if desired. If more than 12 characters are in a message, the display may be scrolled across the face of the display. Each character is formed from a 5x7 dot matrix. A spaced single row of underline dots for a cursor accompanies each character.

The display viewing area is approximately 0.25" x 1.5". A low-power LCD controller 36 is connected directly to microcontroller 30 by means of the I²C bus interface which is discussed in detail below. To reduce bus traffic and power consumption, display controller 36 has an on-chip memory that can store the whole display and needs only be refreshed or updated by the controller 30.

Commands from the user are entered by means of momentary switch 26 which is preferably mounted toward the non-tip end of the pen. This switch is depressed by the user to, for example, view a page message, or to scroll through the system menu functions. Optionally, one or more additional switches (not shown) may be included elsewhere on the surface of the pen to control functions of the pen, if desired. A spring-biased momentary switch may also be placed under the pen clip 100 which is activated by depressing the clip.

The pen body also contains an audio speaker 24. Speaker 24 preferably has a dynamic range of at least 620 Hz - 2500 Hz in order that it may be able to reproduce single and Dual-Tone-Multi-Frequency (DTMF) tones with a reasonably flat response for dialing a telephone and for indicating other information to the user. The pen body preferably includes one or more holes over the speaker to enable sounds generated by the speaker to be heard outside the pen housing.

As shown in FIG. 2, the present personal communication system comprises several sub-systems which cooperate to provide a number of personal communications functions. A microprocessor-based controller 30 acts as the heart of the system integrating the functions of the various subsystems.

A conventional RF paging system is provided by means of RF pager 32. RF pager 32 is preferably an industry-standard POCSAG paging system which operates in the 928-932 MHz band so as to conform to US standard paging systems. Different models of the basic system can be derived to provide paging service over a wide frequency range from 25 MHz up to 1 GHz. Such paging systems are well known, and described in more detail in the article entitled "A Single Chip Paging Receiver" by G. Luff et al., published by Philips Telecommunications Review.

While the invention will be described with respect to a display pager (a pager which can store and display received telephone numbers or messages), it is readily foreseen that the present invention may employ a tone-only pager. In such a pager, the pen will notify a user by beeping or other notification means when a page is received, but will not display the telephone number. This type of pager is used,

for example, by an employer to notify an employee to call into a central station.

As shown in FIG. 3, an antenna 44 receives the RF paging signal. Antenna 44 is preferably a quarter-wave antenna disposed within the body of the pen. The antenna may be located in the pocket clip 100, if desired. The paging signal is fed to a low noise amplifier and mixer 46 which reduces the 900 MHz RF paging signal to a 470 MHz baseband by a local oscillator on the signal frequency. The 470 MHz paging signal is then fed to pager receiver 48, for example a Philips Semiconductor UAA 2080T Advanced Pager Receiver. A block diagram for the UAA 2080T Advanced Pager Receiver is shown in FIG. 5. The receiver 48 is a low-power radio receiver circuit that employs direct FM Non-Return-to-Zero (NRZ) Frequency-Shift-Keying (FSK). The receiver 48 demodulates the incoming radio signal and converts it to raw FSK data.

The pager receiver 48 generates a data output signal which is fed to POCSAG (Post Office Communications Standards Advisory Group) paging decoder 50, preferably a Philips Semiconductor PCF 5001T POCSAG Paging Decoder, which converts the incoming FSK signal into an ASCII data stream containing paging messages according to the protocols set forth in the POCSAG standard CCIR radiopaging Code No. 1. A block diagram for this paging decoder is shown in FIG. 6. The POCSAG paging decoder 50 preferably includes an EEPROM which stores up to 4 user addresses which identify the pager. One or more of these user addresses may be reserved for the security disable feature discussed in detail below.

POCSAG paging decoder 50 decodes the demodulated paging signal and determines whether the paging

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signal includes any messages addressed to that unit based upon addresses stored in its on-board EEPROM. If a message is received which is addressed to a user address not reserved for security features, the paging decoder decodes the paging message and generates an output data stream, preferably as RS-232 serial data, to microcontroller 30. The POCSAG paging decoder also preferably generates an alarm interrupt to the microcontroller in advance of sending the paging data to the microcontroller 30 to alert the microcontroller to the incoming ASCII data. When an alert interrupt is received from the POCSAG paging decoder 50, the controller 30 is activated (the clock oscillator is started) and the controller will receive the serial ASCII data stream. This alarm signal enables the microcontroller 30 to operate in a power-conserving "STOP" mode until it must be activated to receive the page message.

Microcontroller 30, preferably a Philips PCD-3344 or PCD-3352A microcontroller, receives the ASCII serial data and stores it in a conventional memory 42. A block diagram of this microcontroller is shown in FIG. 4. Memory 42 is preferably a 128 byte EEPROM memory which is sufficient to hold 256 digits of numbers of 128 characters of alphanumeric information. This is sufficient for about 25 telephone numbers or 5 names and numbers. Memory 42 is nonvolatile so that the information stored is retained when power is turned off or the battery drains. If additional memory is required, a memory expansion module may be used to increase the memory capacity. EEPROMs with substantially higher densities may be included in the system, if desired. Even larger memories are possible using FlashEPROMs and a small interface circuit.

The memory 42 is used in conjunction with the microcontroller 30 to provide the following functions in the system:

- a) a telephone directory containing names and telephone numbers, and optionally to store addresses;
- b) a memory containing one or more telephone calling card numbers;
- c) a directory of paged messages which have been received; and
- d) a event timer to alert the user to scheduled events.

Obviously, it is desirable to have a larger memory capacity in order to enable the system to handle more of these functions and to be able to store more names and telephone numbers. For example, a larger memory of 8192 bytes will accommodate a directory of about 250 names and numbers. This number is reduced if addresses and other information are included.

Microcontroller 30 preferably consumes a minimum of power when the user is not actively controlling the system. Microcontroller 30 will only consume power when POCsAG paging decoder 50 is receiving data or when the user is performing a task. At all other times microcontroller 30 is in "STOP" mode and consumes only a few micro-amps of current.

Microcontroller 30 supports several input/output mechanisms in order to provide the complete functionality of the system. Internally, it includes a computing engine controlled by an internal ROM (read-only-memory) that sequences through instructions controlling all the functions of the system. The microprocessor also has several external interfaces to communicate with the various peripherals within the system. Most external

peripherals are preferably connected to microcontroller 30 via an industry standard I²C bus which allows the microcontroller 30 to communicate with the peripheral devices.

Microcontroller 30 preferably includes an on-board conventional DTMF tone generator 34. DTMF generator 34 is connected to audio speaker 24. When a page message is received by microcontroller 30, DTMF tone generator 34 is caused to generate a single frequency tone or melody to the speaker to notify the user that a page has been received. This beeping feature may be disabled using the menu system discussed in detail below.

When a page is received, microcontroller 30 may also access real-time clock IC 60 to obtain a time and/or date stamp to append to the telephone number from the page. The time/date stamp is stored in the EEPROM 42 along with the page telephone number. Real-time clock IC 60 is similar to that in a personal computer and is capable of communicating with the microcontroller 30 by means of the I²C bus. Real-time clock 60 is also used as an event timer to sound an alarm or beep generated by DTMF tone generator 34 at a preset time to tell the user, for example, that an appointment is due. The event timer can be coupled to a message held in memory 42 that will automatically scroll across the LCD display when the event occurs. The capacity of events and associated messages is limited by the total amount of memory available in the system. Since both events and telephone numbers are stored in EEPROM memory 42, the number of scheduled events reduces the number of telephone numbers that can be stored by the system. Of course, separate memories may be provided for each function, if desired. The real-time clock 60

preferably contains 256 bytes of volatile memory that can be used to supplement the main memory for limited amounts of time. This memory can be used to store paged messages or timed events. The real-time clock can also be used to display the current time and date on the LCD display when other information is not being presented.

When a page is received, the user may access the page information by depressing switch 26. Microcontroller 30 detects that the switch has been depressed and generates the necessary signals to retrieve the page message from memory 42 and to display it on LCD display 38 through display controller 36. Using the menu interface, the page data can be marked for later download or reuse, or deleted.

The system includes a telephone number repository contained in memory 42. The telephone number repository may include one or more telephone calling card numbers, or a personal directory of telephone numbers and received pages. If desired, the user may scroll through the list of numbers using switch 26, and select a number to be dialed by double-clicking switch 26. The user then places speaker 24 in close proximity to the receiver of a touch-tone telephone and depresses switch 26. Microcontroller 30 retrieves the selected telephone number from memory 42, and generates the necessary commands so that DTMF tone generator generates the DTMF tones through speaker 24 to dial the telephone number. A single transistor amplifier or other amplifier may be required to drive the speaker at audible levels. In the case of calling card numbers, an access number may be stored in memory along with the calling card number. When the system

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is instructed to make a telephone call using the calling card number, microcontroller 30 automatically dials the access number before the calling card number is dialed. DTMF tone generator 34 may also be used to generate tones to verify a selection from a menu or to signal an error condition.

Power for the system is provided by means of one or more batteries 22. Preferably, a single quarter-size nickel cadmium or nickel metal hydride N cell is used to power the system. This type of battery has 1.2 volts, which is generally insufficient for the electronic circuits within the system. Accordingly, the voltage is raised to 3.3 volts by a conventional buck regulator, such as a maxim 778. This setup provides maximum availability of power from the battery even as the voltage from the battery drops. While a non-rechargeable battery may be used in the system, this is not preferable since due to the limited space available within the pen for the battery, the battery would need replacement within several days. Accordingly, a rechargeable battery system is preferred that will operate for a minimum of 24 hours on a single charge. In normal use the pen must generally be returned to the "inkwell" (discussed below) once a day for recharging.

Communication to and from microcontroller 30 is preferably provided by an I²C bus interface. This is an industry standard interface that is used for low power and relatively low speed systems. The I²C bus is used to communicate with the LCD display 38, the EEPROM memory 42, the real-time clock 60 and the pager. The I²C bus uses only two wires, serial data and serial clock, to carry information between devices connected to the bus. Each device connected to the bus is software addressable by a unique

address. Serial, 8-bit bi-directional data transfer can be made at up to 400 kilobytes per second using this bus.

In addition to inter-component communications within the pen, the I²C bus may also be used to connect to an external interface to allow communication to a personal computer or other attached peripheral device. As shown in FIG. 1, four electrically conductive button contacts 50 or four electrically conductive rings insulated from each other (such as on RCA plugs) are provided toward the tip end of the pen. As shown in FIG. 7, an inkwell having a shape corresponding to the pen includes four electrical contacts which engage the button contacts 50 on the pen. Two of the contacts on the pen are connected to the I²C

interface and enable a user of the system to gain access to the I²C interface of the microcontroller 30 through the inkwell. The other two contacts are connected to battery 22 in the pen. The inkwell includes a conventional battery recharger which is connected to these two contacts. The inkwell plugs directly into an AC outlet and preferably contains a power conditioning circuit to ensure correct operation of the recharging system. When the pen is inserted into the inkwell, the battery 22 will be automatically recharged.

The pen and the inkwell include a keying mechanism to insure that the battery charging contacts on the pen engage with the corresponding battery charger contacts on the inkwell, and the I²C interface contacts on the pen engage with the I²C interface contacts on the inkwell. The I²C contacts on the inkwell may be connected to, for example, a personal computer, a personal digital assistant, or

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other controller which would enable data to be uploaded to the microcontroller 30 and downloaded from the microcontroller 30. This would enable a user, for example, to load a telephone list to the microcontroller memory, or to load alarm times and/or notes from the computer or personal digital assistant. Preferably, when it is desired to load information to or from the pen, a menu selection is made on the pen which effectively shuts down the microcontroller 30. The I²C contacts on the inkwell would then be connected to the back of a personal computer. An external controller on the PC would seize control of the I²C bus and have full access to the pen memory. Other interface techniques which accomplish the same purpose are readily foreseen.

FIG. 12 shows a flow diagram for operation of the external communication system. This flow chart is begun by selecting "external communication" or the like from the system menu. This initiates a start sequence which sets up the system for external communication. If desired, the user may exit at this time by clicking the button. The microcontroller then waits to receive a message via the I²C bus. A message is received, the microcontroller determines whether the address that the external device desires to access is valid. If so, the microcontroller determines whether the request is to read or write to the system memory. The microcontroller may be programmed to prevent read or write access to certain portions of the memory. Accordingly, the microcontroller determines whether a read or write is permissible, and if so, performs the read or write function.

The microcontroller software preferably provides a menu system which provides a link between all

the hardware services within the system and the user services for reception, display and dialogue of information. It also provides for various modes of operation and for running interface protocols to communicate with the LCD display and I²C interface.

The main user interfaces to the menu system are via switch 26 and LCD display 38. Microcontroller 30 preferably responds to two modes of use of switch 26: a single 'click' and a 'double' click, in much the same way as the mouse button of a personal computer operates. A single 'click' is preferably used to descend through a menu of options and a double 'click' to select an option to initiate an action. The switch closure is detected by the microcontroller 30 and a variable delay timer is activated to allow for switch bounce and to verify that the switch has been deliberately depressed. The speed at which a 'double click' is accepted by the system is a programmable option that the user can select to suit individual style.

The menu system is the operating system of the pen. A hierarchy of menus is used to allow the user to rapidly access a function or service and gain access to information. It is also used to configure the system to best suit the user's needs as they change.

When the unit is turned on, microcontroller 30 will perform a self-test and then automatically enter the menu system. The microcontroller 30 will generally wait in the "STOP" mode until a user input is received. The menu system will then display an option which the user may either select with a double click on button 26 or pass over with a single click on button 26. Selecting an option will cause one of the following to occur: either another menu will be

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entered to provide options within the newly selected category or an action is performed, i.e., a number is dialed out. A flow diagram showing operation of the menu system is shown in FIG. 8. The menu system is preferably implemented as a stack which is contained in memory and enables the size of the system software or firmware to be minimized. As a user traverses down through the menus, the previous menus are pushed on to the stack. As the user traverses up through the menus, previous menus are popped from the stack. In addition, options which are to perform functions may be stored in the stack as well.

This mechanism allows the user access to a variety of functions and information with a single line display and a single push button. The following are some of the modes and services provided by the menu system and operating system software:

PAGER MODES

- | | | |
|---------------|---|--|
| Standby mode | - | Real time clock is displayed only |
| Alert only | - | Paging reception active - no telephone numbers saved |
| Priority mode | - | Alert mode with priority override to Collect mode |
| Collect mode | - | Paging reception saves numbers for display and dialing |

DISPLAY MODES**STANDBY**

- | | | |
|-------------|---|---|
| Blank | - | No display |
| Time only | - | Time and date only |
| Time & Page | - | As Time only, but with Alert and Priority indications |
| Last Page | - | Displays last page received |

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ACTIVE

MENU

- Set Page Mode - Scroll through options and select as above
- Set Display Mode - Scroll through options and select as above
- Select Dialer Mode - Scroll through options and select
- Select Messages - Scroll through received pages and select
- Select Calling Card - Scroll through stored numbers and select
- Select Phone Number - Scroll through stored numbers and select
- Select Time display mode - Scroll through options and select
- Set Time and Date - Select field and scroll through values, and select
- Select Communication - Enter program mode for communications with host.

Several automatic functions can be configured through the menu system. For example, it is desirable in Pager mode that a received page be easily turned into a return call. The system can be set to detect whether a page is local or long distance and select a calling card number appropriately. All the user must do is push the button to activate call back. For a long distance telephone call, a first button push dials out the long-distance access number, a second push sends the calling card number and third push dials the number received by the pager. If a local call is received then a first push dials the received number with a

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'0' or other prefix and a second push dials the calling card number.

FIG. 9 shows a flow diagram of the system operation for receiving a page. As discussed above, the paging system generates a paging interrupt to the microcontroller which reads the paging message to memory. If time stamp mode is enabled, the message is saved along with the time stamp from the real-time clock. If the user alert mode is enable, a tone is generated by means of the DTMF tone generator. Finally, if an auto-dial-out option is enabled, the message will be pushed onto the menu stack. In this mode, if the user selects the message via the menu system and clicks on the message, the telephone number of the message will be automatically dialed out. Thus, the stack-based menu system can be used to carry out personal information functions in addition to simply traversing menus.

Calendar events are detected by the real-time clock and the user is beeped automatically at a preset time. This automatically causes the menu system to enter the calendar menu so that the user need only double click to select the timed event and see the displayed message. FIG. 10 shows a flow diagram for operation of the scheduling system on the pen. The system operates in a loop comparing schedule times to the current time. When a match occurs, the user is alerted, if this mode is selected. Finally, if the auto-mode is selected, the scheduled event may be pushed onto the stack along with an associated function. When this entry is selected from the menu system, the desired function will be carried out.

Collisions can occur between functions in the pen. For example, a calendar event may occur and

beep the user at the same time that a page is received and also beeps the user. When this occurs, the system stacks up the events and indicates to the user that the stack has multiple entries on it by changing the display so that, for example, it flashes. It is readily foreseen that the menu system of the invention may be modified in many respects while keeping within the scope of the invention.

The present invention may include one of several security mechanisms to prevent misuse of the system. A password protection scheme can be in force that only permits access to the pen's information if a password is entered correctly. The password is entered via the menu system by selecting a series of characters and numbers. For example, the user may scroll through the character set with each click of button 26 or if the button is held down the cursor will scroll automatically. Once the correct character is found, the user may double-click to move to the next character of the password. A five or six character password can thus be readily entered into the pen and provide, with a 40 character set, over 4 billion combinations. The password, if enabled, is entered every time the pen is powered-up and remains in force as long as the pen is active. It may be desired that only the telephone directory or other system function be protected in which case the password need only be entered when that menu is entered.

A more powerful security system is also included. When a page is addressed to an address reserved for disabling the system, all pen functions may be terminated by microcontroller 30. Microcontroller 30 preferably contains an on-board memory which is not accessible via the I²C bus (which might

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otherwise enable the security feature to be bypassed via the inkwell). When a disable function is activated, the microcontroller makes a non-volatile memory entry which prevents use of any of the system functions until the system is re-enabled from the paging transmitter. This security system can be used if the pen is reported lost or stolen and will prevent calling card misuse and also prevent access to the stored information. Another page, using either the same security address or another address reserved for enabling the pen, can be sent to re-enable the pen. When re-enabled, microcontroller 30 can delete the memory entry which kept it disabled. The enable/disable mechanism is linked only to the paging receiver and cannot be overridden by the user.

A second level of security may be offered, as shown in FIG. 11. In this mode, a security page would transmit a message for turning on or off the pager. The message would also include a key message, and a new key. If the transmitted key matches the key stored in the system memory, the pen would turn on or off as instructed, and the new key would operate as the key for the next enable/disable operation. If the key did not match, no operation would occur. This mode reduces the likelihood the possibility of bypassing the system security by determining the key.

Another level of security can also be offered whereby the pen can be sent a security page requiring the user to enter a password in response to an action performed by the pen. This could be, for example, if the user's telephone calling card access is beyond the user's normal profile, or if the pen is being used to access a banking system at a high security level, a password could be required from the user.

These functions preferably do not require complex overhead within the pen. Rather, the pen is simply being used to dial out a number or series of numbers. The receiving system determines that further security is required and sends a special page to the pen. The password is then entered by the user and the system carries on. If the entered password does not correspond to the stored password (which could be changed by the requesting page) then further access to the pen is denied. The pen can only be reactivated by a security page or by entering a full system password. Both security system can be used separately or in combination to protect the user information and to prevent credit fraud through unauthorized use of calling card numbers.

In order to manufacture the present invention with all of the components contained within the body of a pen, all of the integrated circuits in the system are used in their bare die form. No plastic of ceramic package surround the individual chips. Rather the bare IC dies are mounted directly to the circuit. This reduces the physical volume of the chips by a factor of at least ten and enables the assembly of the system inside the pen.

The circuit board 20 which carries all of the electronic components of the system is preferably mounted between speaker 24 and batteries 22. Circuit board 20 is manufactured using flexible manufacturing techniques which enable all of the components to fit within the pen. Rigid lands are provided upon which the electronic circuit boards are mounted. The lands are joined together by a flexible circuit so that the entire assembly can be folded-up into a 3-dimensional volume as opposed to a more traditional 2-D circuit board. The circuit connections between the circuit

boards on the lands are made with conductive polymer inks that are printed onto the surface of a flexible material such as Kevlar. The inks are then cured and the rigid lands are laminated to the flexible material. Typically the bare IC dies are then attached to the circuit board via wire bonding. If desired, the IC dies may be mounted face down onto the circuit before the inks are cured and the dies may be attached directly to the circuit as part of the curing process.

Although the present invention has been described in detail with respect to certain embodiments and examples, variations and modifications exist which are within the scope of the present invention as defined in the following claims.

CLAIMS

1. A personal communication device which comprises:
 - a) a housing shaped like a writing instrument, the housing having a tip end having an aperture extending therethrough;
 - b) a writing element disposed within the housing and extending through the aperture at the tip end;
 - c) a microcontroller located within the housing;
 - d) memory means located within the housing and accessible by the microcontroller;
 - e) a display controllable by the microcontroller and mounted on the housing visible exteriorly thereof;
 - f) a paging system having one or more addresses associated therewith, the paging system comprising:
 - I. an antenna located on or within the pen housing for receiving RF paging signals comprising paging messages, each paging message associated with one or more pager addresses;
 - II. a paging receiver for demodulating the RF paging signals received at the antenna; and
 - III. a paging decoder for decoding selected paging messages in the demodulated RF paging signals addressed to paging system and transmitting the paging messages to the microcontroller;
 - g) a speaker located within the housing, the housing having one or more apertures extending therethrough adjacent to the speaker for enabling

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sounds generated by the speaker to be audible outside the housing;

h) a DTMF tone generator located within the housing and connected to the speaker, the DTMF tone generator controllable by the microcontroller to generate DTMF tones for automatically dialing telephone numbers; and

i) a source of power disposed within the housing for providing electrical power to the microcontroller, the paging system, the speaker, the display, the memory means and the DTMF tone generator.

2. The apparatus according to claim 1 further comprising:

a switch located on the housing, closure of the switch being detectable by the microcontroller; and

a control system operable on the microcontroller and accessible and controllable by a user using the switch to perform personal information functions, the control system comprising:

I. means for storing paging messages in the memory;

II. means for controllably displaying received paging messages and stored paging messages on the display;

III. means for retrieving messages from the memory for display;

IV. means for deleting messages from the memory; and

V. means for retrieving a paging message comprising a telephone number from the memory and for causing DTMF tone generator to dial the telephone number.

3. The apparatus according to claim 2 wherein the control system further comprises:

means for storing telephone numbers and other personal messages in the memory;

means for retrieving and displaying the telephone numbers and other personal messages.

4. The apparatus according to claim 3 wherein the control system further comprises means for retrieving a telephone number from the memory and for causing DTMF tone generator to dial the telephone number.

5. The apparatus according to claim 2 further comprising means for storing one or more telephone calling card telephone numbers, the control system further comprising means for retrieving the telephone calling card number and for causing DTMF tone generator to dial the calling card number.

6. The apparatus according to claim 5 wherein the calling card number has an associated access telephone number, the control system causing DTMF tone generator to dial the access number prior to dialing the telephone calling card number.

7. The apparatus according to claim 1 further comprising means for detecting a paging message containing a disable message, the controller disabling operation of the personal communication device in response to receipt of the disable message.

8. The apparatus according to claim 7 further comprising means for detecting a paging message containing an enabling message, the controller re-enabling operation of the personal communication device in response to receipt of the enabling message.

9. The apparatus according to claim 1 further comprising:

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a disable address in the paging decoder, the paging decoder determining if a received paging message is addressed to the disable address; and

means for at least partially disabling operation of the personal communication device in response to receipt of a paging message addressed to the disable address.

10. The apparatus according to claim 9 further comprising:

an enabling address in the paging decoder, the paging decoder determining if a received paging message is addressed to the enabling address; and

means for re-enabling operation of the personal communication device in response to receipt of a paging message addressed to the enabling address.

11. The apparatus according to claim 2 further comprising:

a disable address in the paging decoder, the paging decoder determining if a received paging message is addressed to the disable address, the controller preventing user access to the control system to at least partially disable operation of the personal communication device in response to receipt of a paging message addressed to the disable address.

12. The apparatus according to claim 1 wherein the source of power is one or more batteries, the apparatus further comprising:

at least two electrical contacts positioned on the exterior of the housing in electrical contact with the batteries; and

a recharging station shaped to have the housing at least partially inserted therein, the recharge station comprising:

at least two electrical contacts positioned to engage with the electrical contacts on the housing

when the housing is inserted into the recharging station; and

means for recharging the batteries in the housing.

13. The apparatus according to claim 1 further comprising:

a data communications line connected to at least the microcontroller or the memory;

two or more data communications electrical contacts positioned on the exterior of the housing connected to the data communications line;

and a data communications interface comprising:

two or more electrical contacts positioned to engage with the data communications electrical contacts on the housing; and

means for enabling data communications with the data communications line in the housing.

14. The apparatus according to claim 12 further comprising:

a data communications line connected to at least the microcontroller or the memory;

one or more data communications electrical contacts positioned on the exterior of the housing connected to the data communications line; and

the recharging station further comprising:

one or more data communications electrical contacts positioned to engage with the data communications electrical contacts on the housing; and

means for enabling data communications with the data communications line in the housing.

15. The apparatus according to claim 2 further comprising a real-time-clock located within the housing and connected to the microcontroller; and the control system further comprising:

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means for time or date stamping paging messages;
means for storing scheduling events in the
memory; and
means for notifying the user of a scheduled
event.

16. In an improved paging system having one or
more addresses associated therewith, the paging
system comprising:

an antenna for receiving RF paging signals
comprising paging messages, each paging message
associated with one or more pager addresses; a paging
receiver for demodulating the RF paging signals
received at the antenna; and a paging decoder for
decoding selected paging messages in the demodulated
RF paging signals addressed to paging system;

the improvement comprising:

means for detecting a disabling paging message;
and

means for at least partially disabling operation
of the paging system in response to receipt of the
disabling message.

17. The apparatus according to claim 1 further
comprising:

means for detecting an enabling paging message;
and

means for re-enabling operation of the paging
system in response to receipt of the enabling
message.

18. The apparatus according to claim 16 wherein
the paging decoder comprises a disable address, the
paging decoder determining if a received paging
message is addressed to the disable address and at
least partially disabling operation of the personal
communication device in response to receipt of a
paging message addressed to the disable address.

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19. The apparatus according to claim 18 wherein the paging decoder comprises an enable address, the paging decoder determining if a received paging message is addressed to the enable address and re-enabling operation of the paging system in response to receipt of a paging message addressed to the enable address.

20. A personal communication device which comprises:

a) a housing shaped like a writing instrument, the housing having a tip end having an aperture extending therethrough;

b) a writing element disposed within the housing and extending through the aperture at the tip end;

c) a paging system having one or more addresses associated therewith, the paging system comprising:

I. an antenna located on or within the pen housing for receiving RF paging signals comprising paging messages, each paging message associated with one or more pager addresses;

II. a paging receiver for demodulating the RF paging signals received at the antenna; and

III. a paging decoder for decoding selected paging messages in the demodulated RF paging signals addressed to paging system; and

d) means for notifying a user of receipt of the selected paging messages.

21. The apparatus according to claim 20 wherein the means for notifying the user comprises:

a speaker located within the housing, the housing having one or more apertures extending

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therethrough adjacent to the speaker for enabling sounds generated by the speaker to be audible outside the housing, the speaker generating a tone upon receipt of the selected paging messages; and

a display mounted on the housing visible exteriorly thereof for selectively displaying the selected paging messages.

22. The apparatus according to claim 21 further comprising a DTMF tone generator located within the housing and connected to the speaker, the DTMF tone generator controllable for automatically dialing telephone numbers contained in the selected paging messages.

23. A personal communication device which comprises:

a) a housing shaped like a writing instrument, the housing having a tip end having an aperture extending therethrough;

b) a writing element disposed within the housing and extending through the aperture at the tip end;

c) a microcontroller located within the housing;

d) memory means located within the housing and accessible by the microcontroller;

e) a display controllable by the microcontroller and mounted on the housing visible exteriorly thereof;

f) a switch located on the housing, closure of the switch being detectable by the microcontroller; and

g) a control system operable on the microcontroller and accessible and controllable by a user using the switch to perform personal information functions.

24. The apparatus according to claim 23 further comprising:

a paging system having one or more addresses associated therewith, the paging system comprising:

- I. an antenna located on or within the pen housing for receiving RF paging signals comprising paging messages, each paging message associated with one or more pager addresses;
- II. a paging receiver for demodulating the RF paging signals received at the antenna; and
- III. a paging decoder for decoding selected paging messages in the demodulated RF paging signals addressed to paging system and transmitting the paging messages to the microcontroller; and

the control system comprising:

- I. means for storing paging messages in the memory;
- II. means for controllably displaying received paging messages and stored paging messages on the display;
- III. means for retrieving messages from the memory for display; and
- IV. means for deleting paging messages from the memory.

25. The apparatus according to claim 24 further comprising:

a speaker located within the housing, the housing having one or more apertures extending therethrough adjacent to the speaker for enabling sounds generated by the speaker to be audible outside the housing;

a DTMF tone generator located within the housing and connected to the speaker, the DTMF tone generator

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controllable by the microcontroller to generate DTMF tones for automatically dialing telephone numbers; and

the control system further comprising:

means from retrieving a paging message comprising a telephone number from the memory and for causing DTMF tone generator to dial the telephone number.

26. The apparatus according to claim 23 wherein the control system further comprises:

means for storing telephone numbers and other personal messages in the memory;

means for retrieving and displaying the telephone numbers and other personal messages.

27. The apparatus according to claim 26 wherein the control system further comprises means for retrieving a telephone number from the memory and for causing DTMF tone generator to dial the telephone number.

28. The apparatus according to claim 25 further comprising means for storing one or more telephone calling card telephone numbers, the control system further comprising means for retrieving the telephone calling card number and for causing DTMF tone generator to dial the calling card number.

29. The apparatus according to claim 28 wherein the calling card number has an associated access telephone number, the control system causing DTMF tone generator to dial the access number prior to dialing the telephone calling card number.

30. The apparatus according to claim 24 further comprising means for detecting a paging message containing a disable message, the controller disabling operation of the personal communication device in response to receipt of the disable message.

31. The apparatus according to claim 30 further comprising means for detecting a paging message containing an enabling message, the controller re-enabling operation of the personal communication device in response to receipt of the enabling message.

32. The apparatus according to claim 23 further comprising:

- one or more batteries in the housing as a source of power for the personal communication device;

- at least two electrical contacts positioned on the exterior of the housing in electrical contact with the batteries; and

- a recharging station shaped to have the housing at least partially inserted therein, the recharging station comprising:

 - at least two electrical contacts positioned to engage with the electrical contacts on the housing when the housing is inserted into the recharging station; and

 - means for recharging the batteries in the housing.

33. The apparatus according to claim 23 further comprising:

- a data communications line connected to at least the microcontroller or the memory;

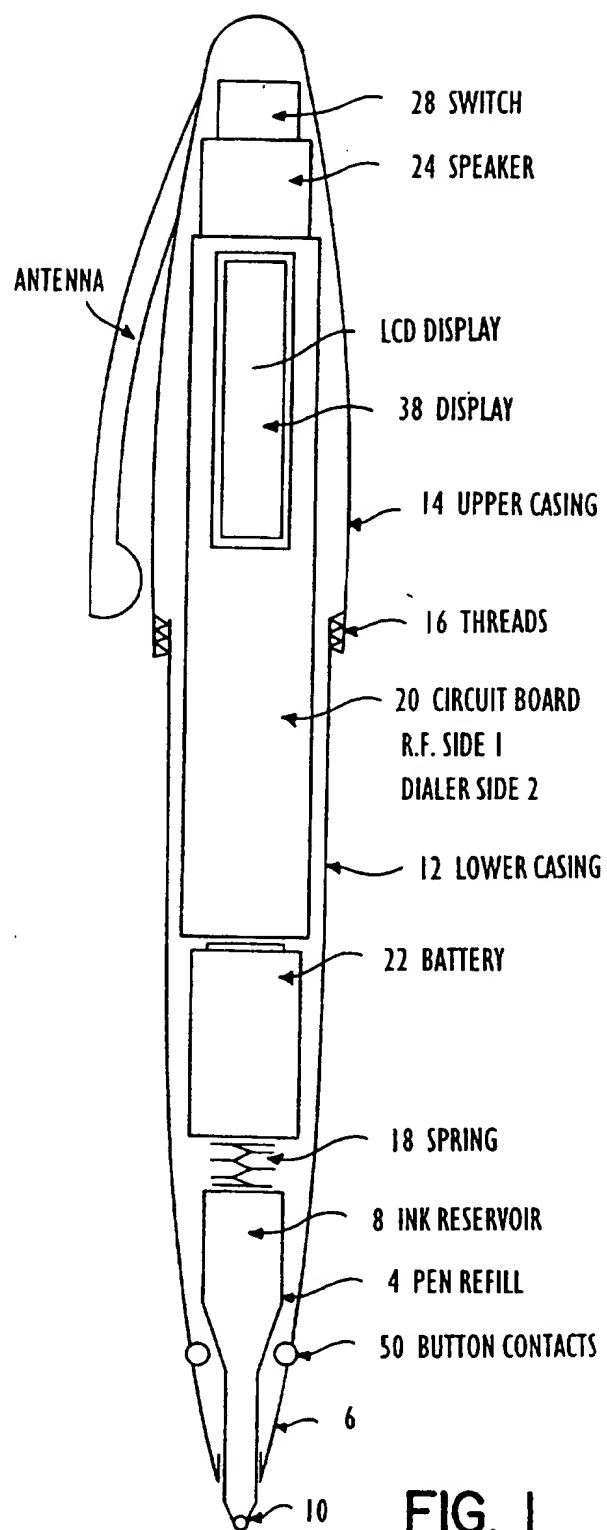
- two or more data communications electrical contacts positioned on the exterior of the housing connected to the data communications line;

- and a data communications interface comprising:

 - two or more electrical contacts positioned to engage with the data communications electrical contacts on the housing; and

 - means for enabling data communications with the data communications line in the housing.

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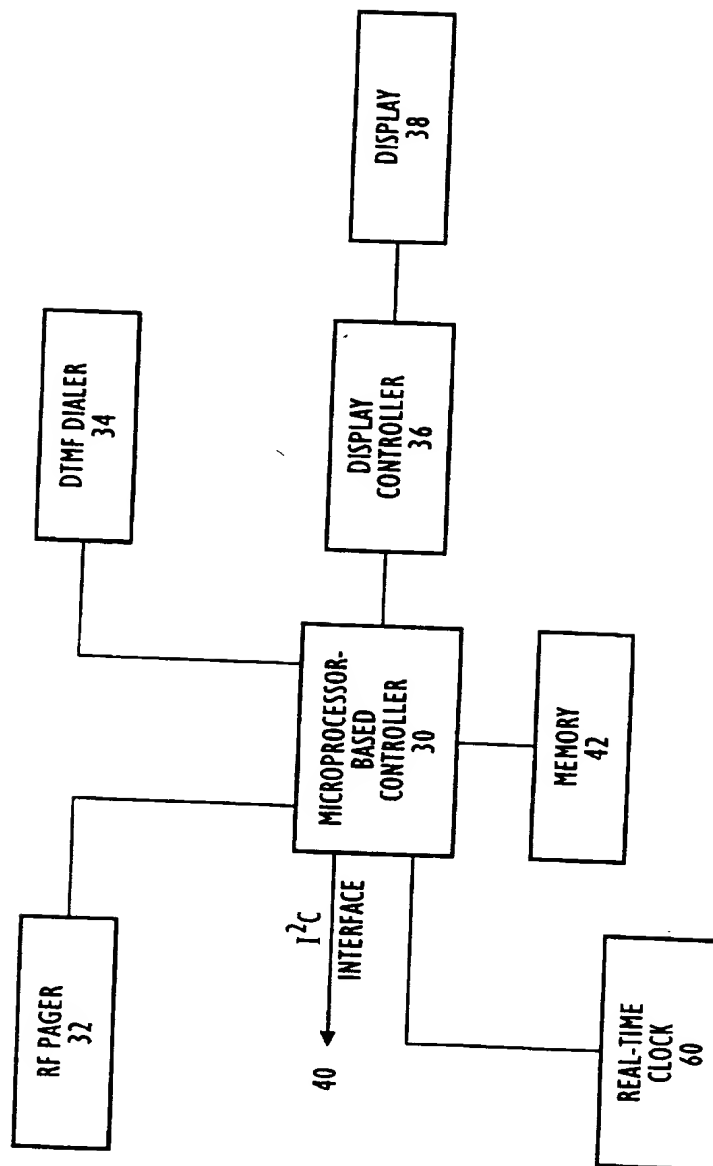


FIG. 2

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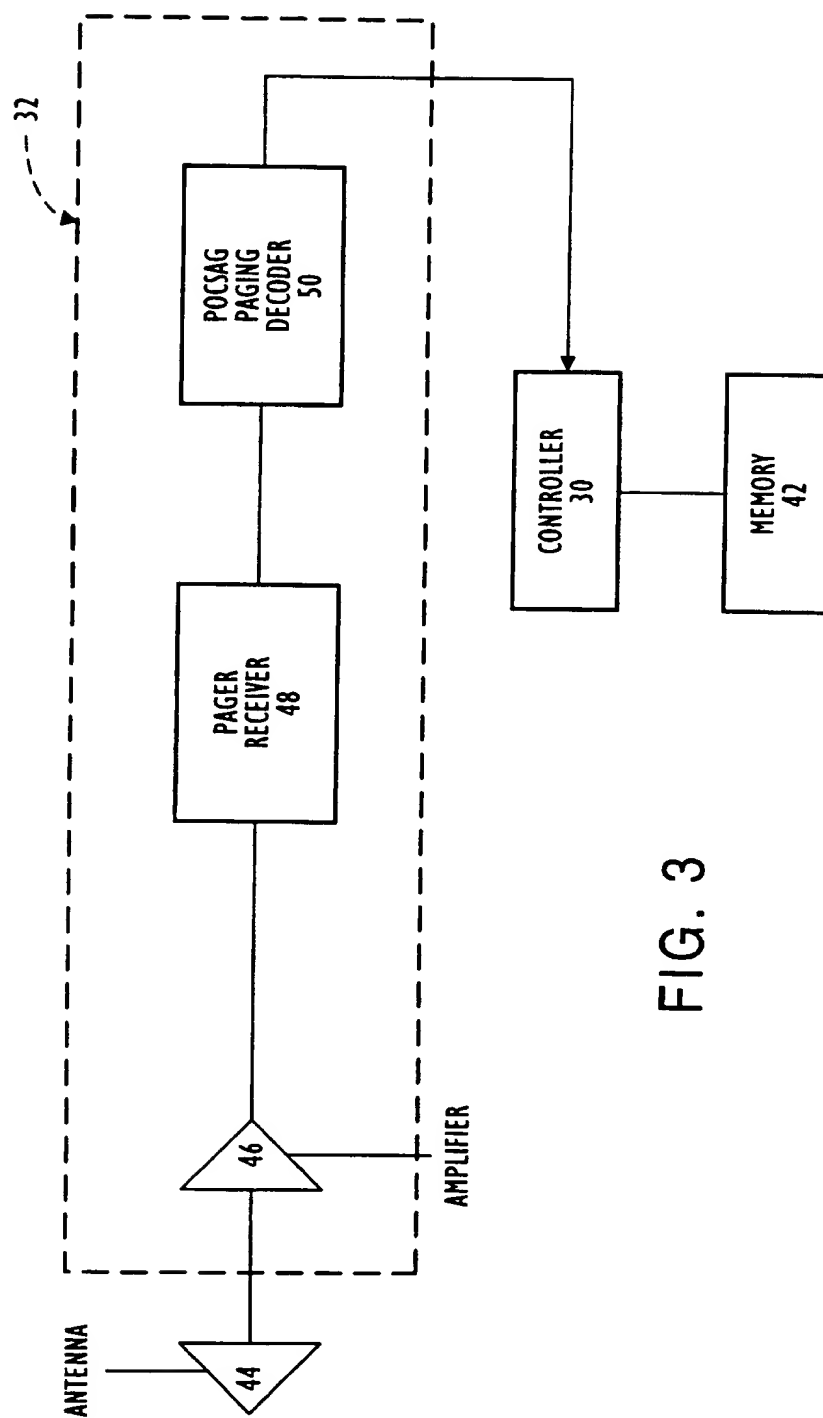


FIG. 3

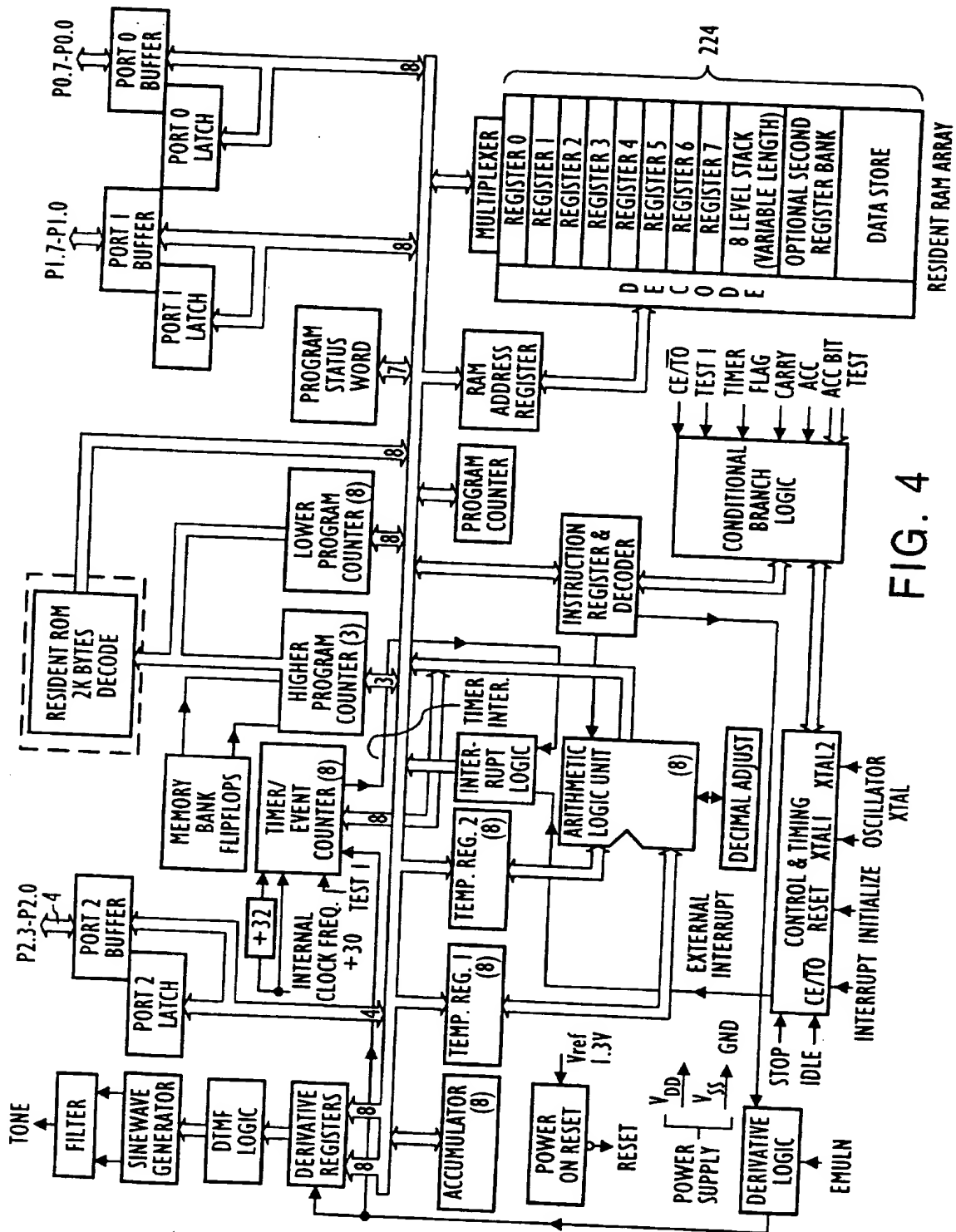


FIG. 4

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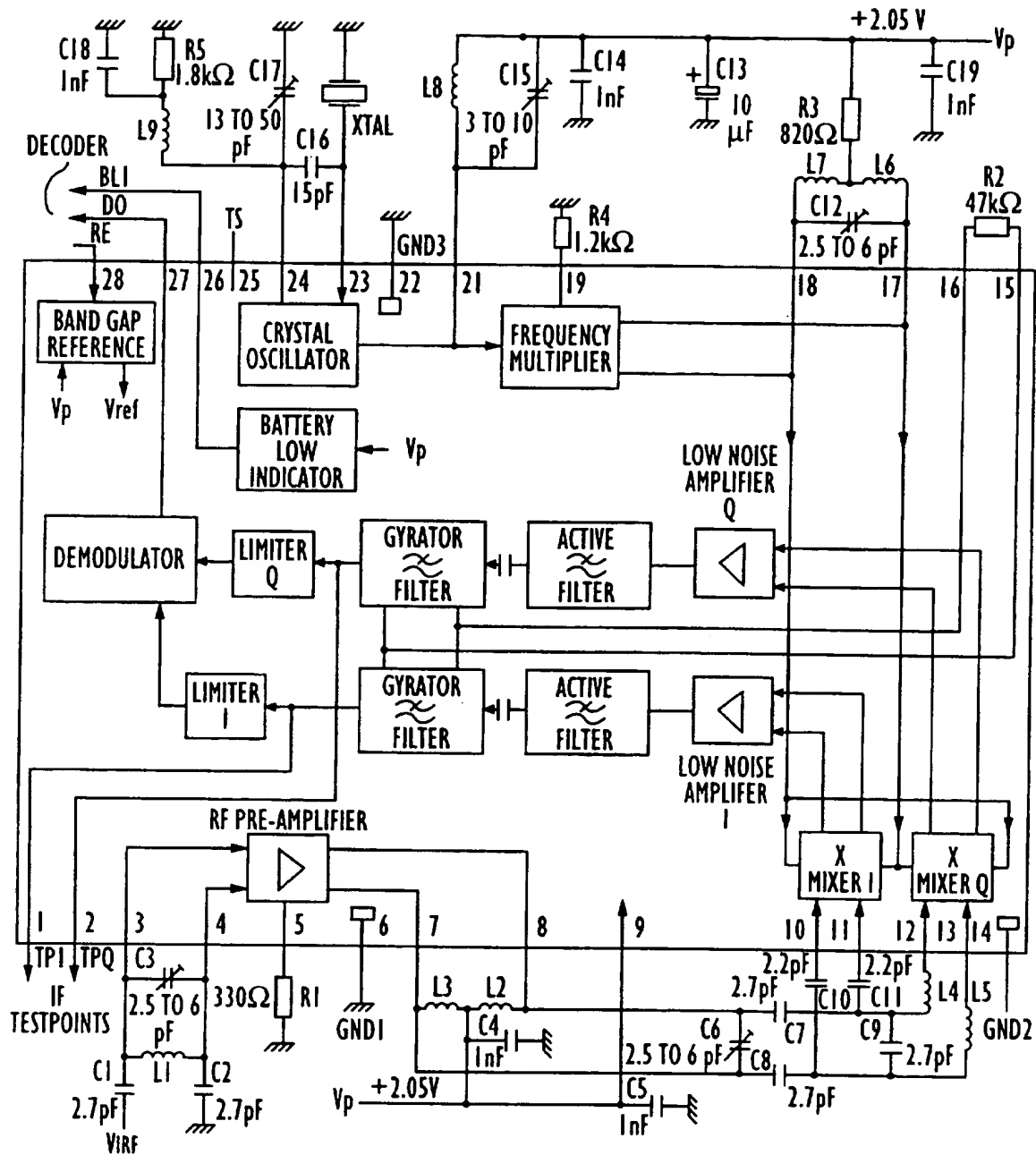


FIG. 5

SHEET 1 OF 2 (10/12)

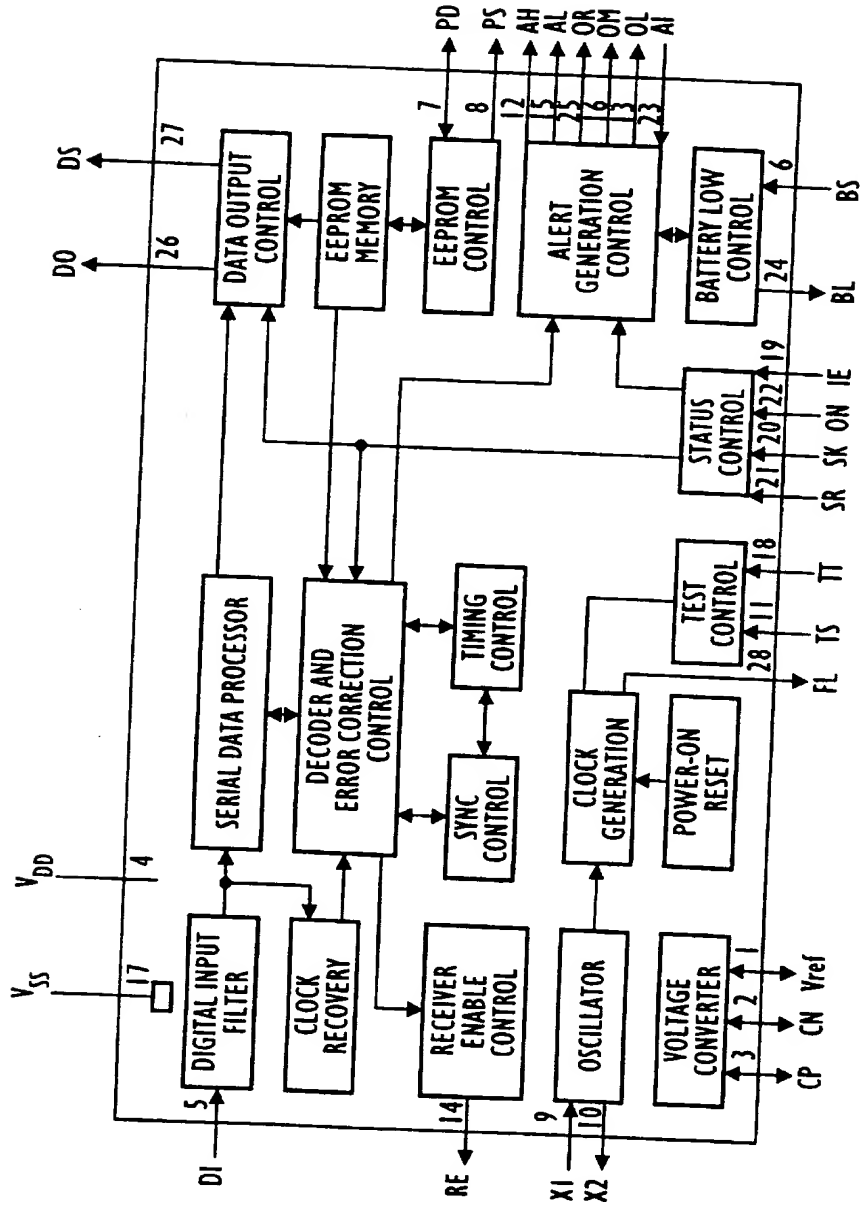


FIG. 6

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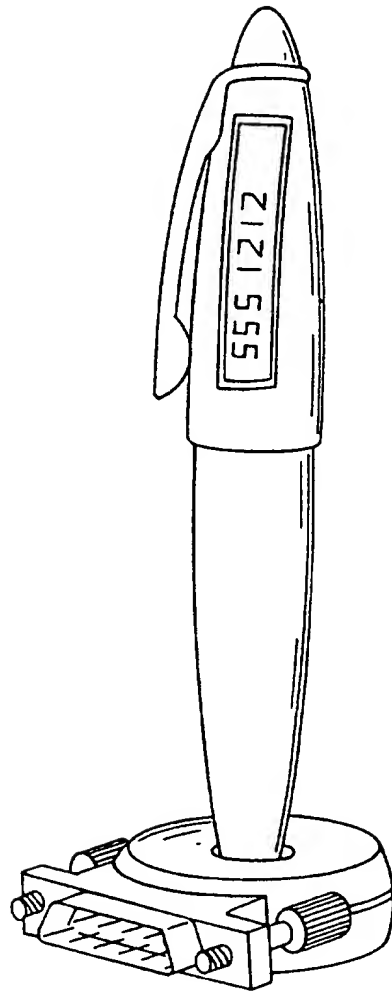


FIG. 7

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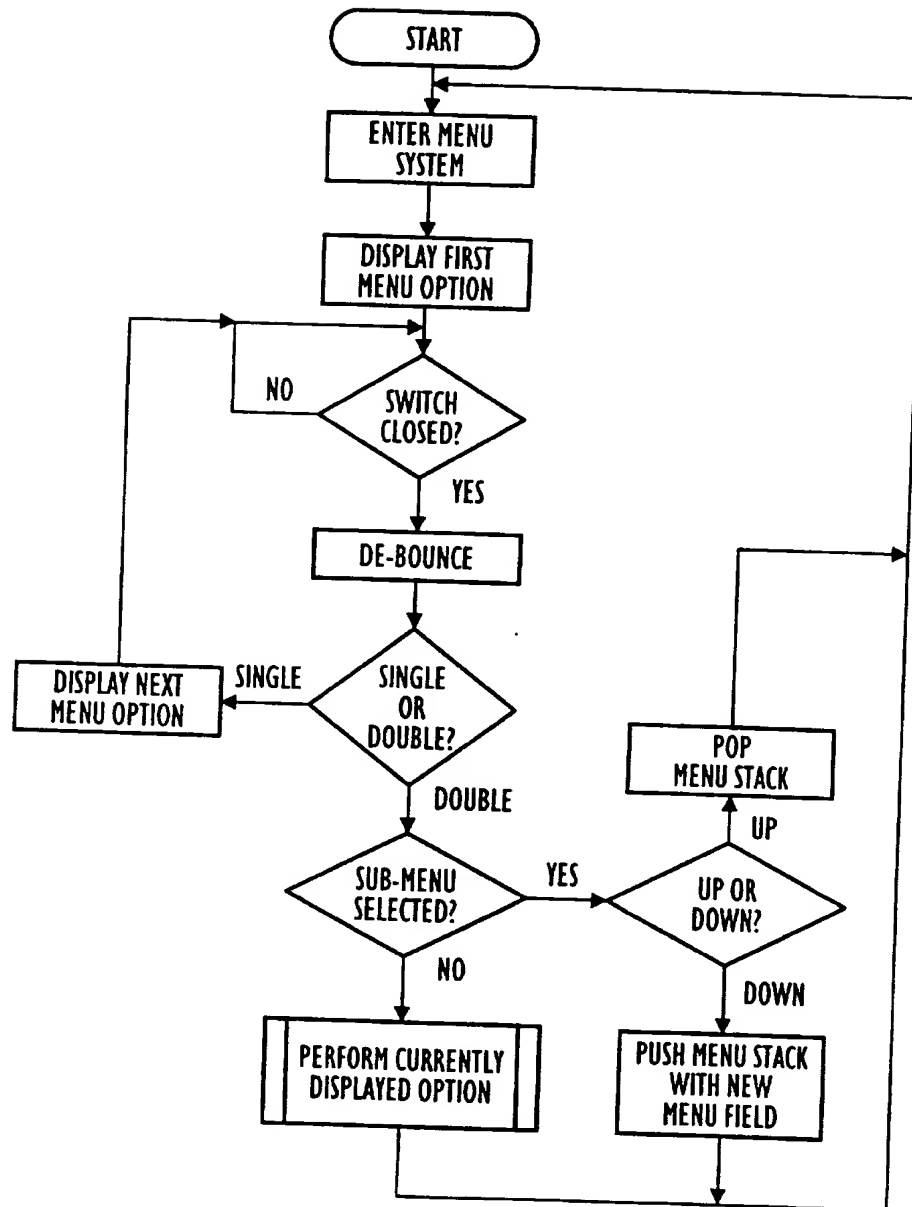


FIG. 8

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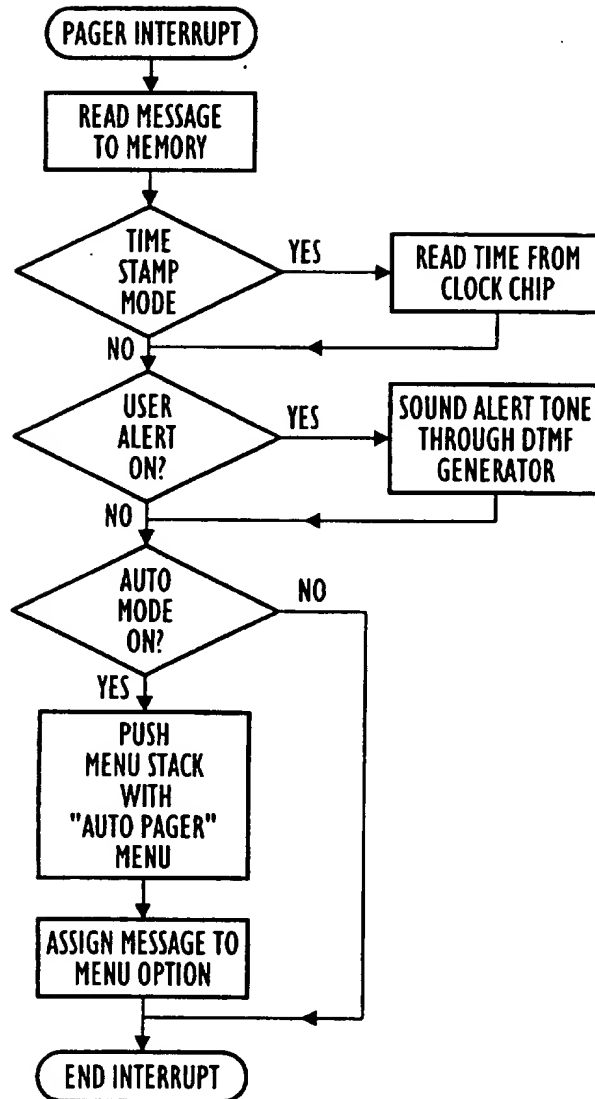


FIG. 9

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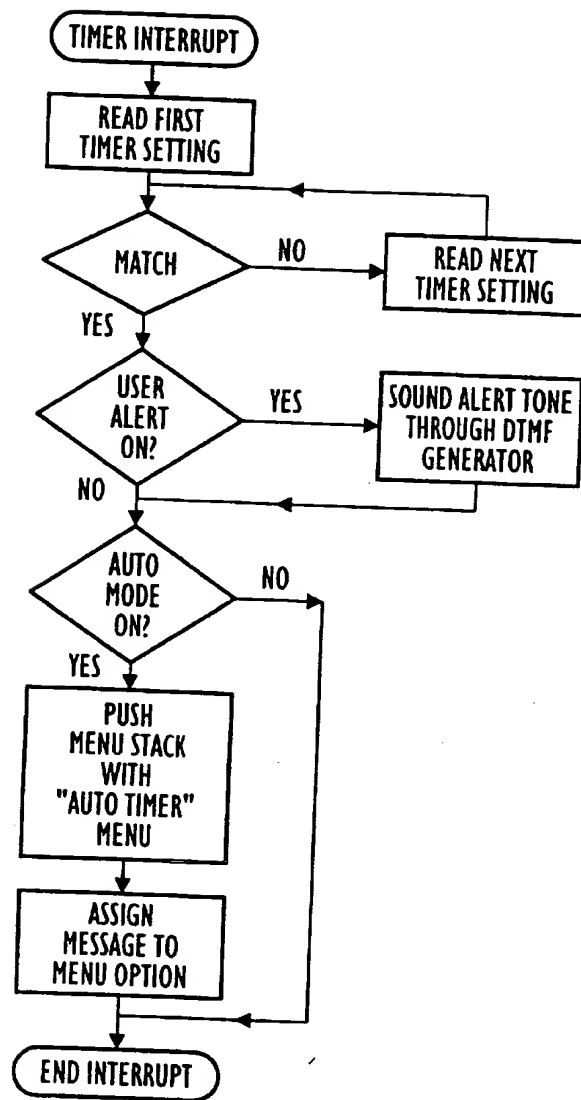


FIG. 10

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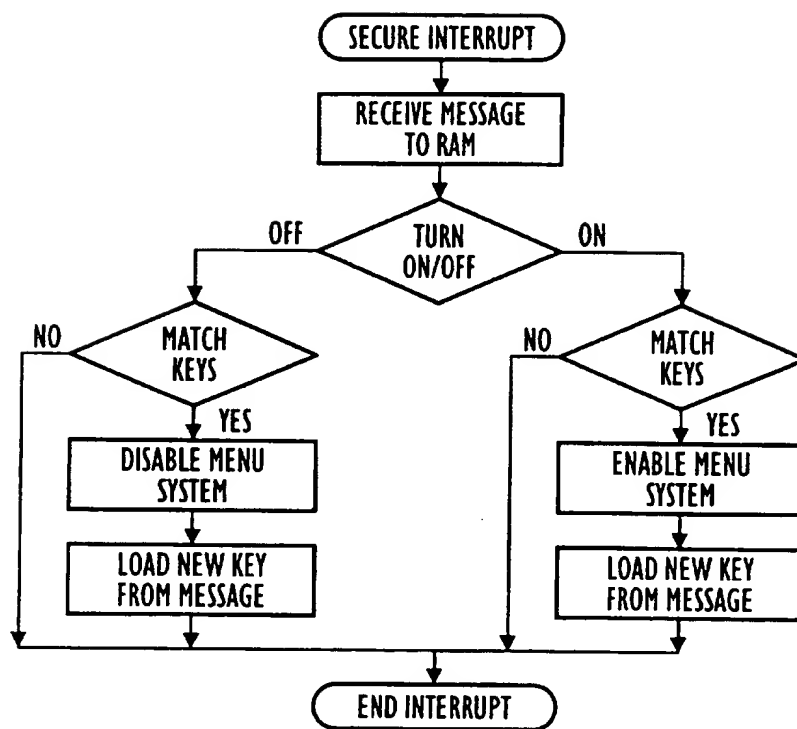


FIG. 11

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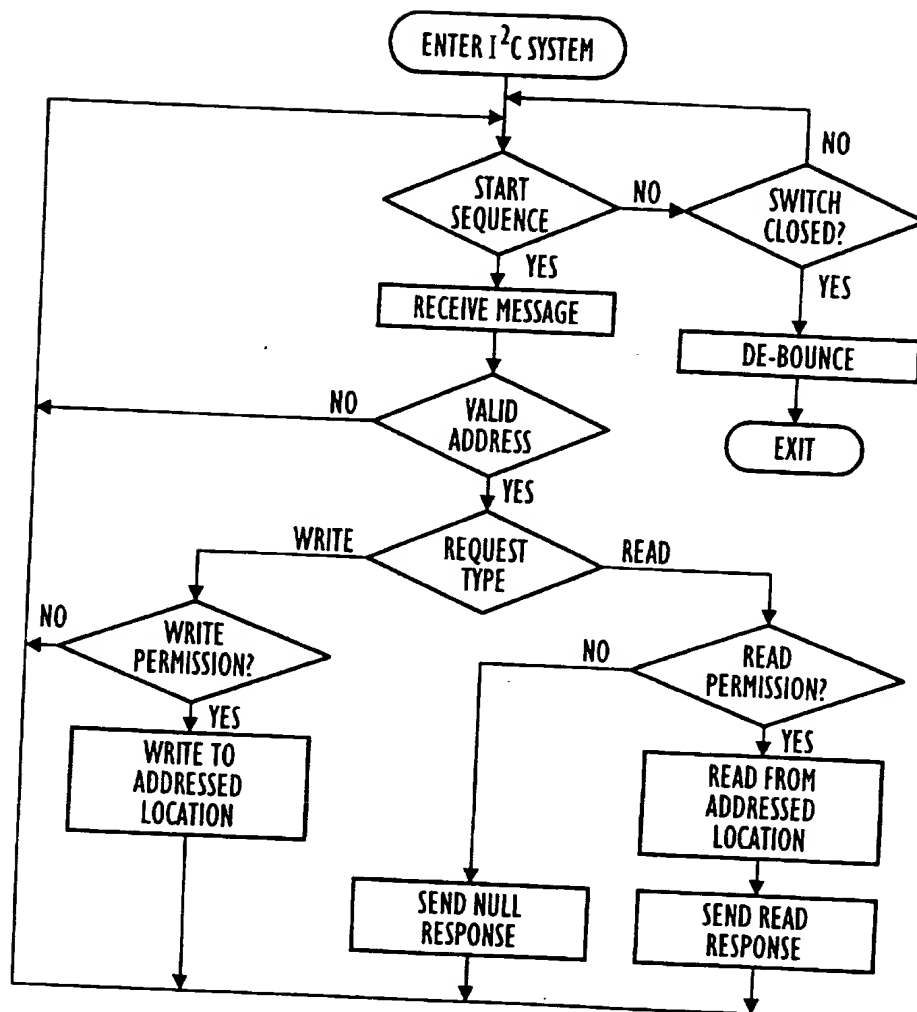


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/09785

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G08B 5/22; H04Q 7/00; H04M 11/00

US CL : 340/825.44, 825.22; 379/57, 355

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/825.44, 825.22; 379/57, 355

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: pen or pencil, receiver#, pager, DTMF tone generator

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 4,870,403 (MORI ET AL) 26 September 1989, Figure 1, col. 1 lines 24-33, col. 2 lines 1-14.	16-19 ----- 7-11, 30, 31
Y	US, A, 5,227,774 (BENOIST) 13 July 1993, Figures 1 and 2.	1-15, 20-33
Y	US, A, 3,739,329 (LESTER) 12 June 1973, col. 3 lines 35-38.	1-15, 20-33
Y	US, A, 4,884,252 (TEODORIDIS ET AL) 28 November 1989, col. 1 lines 39-46.	1-15, 20-33
Y	US, A, 4,490,579 (GODOSHIAN) 25 December 1984, The Figure.	1-15, 22, 25-29

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
E earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

04 OCTOBER 1995

Date of mailing of the international search report

02 NOV 1995

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/09785

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,763,355 (COX) 09 August 1988, Figures 1 and 5.	1-15, 22, 25-29
Y, P	US, A, 5,357,244 (VAN ZIJL) 18 October 1994, col. 1 lines 62-68.	12, 14, 32
Y	US, A, 4,422,071 (DE GRAAF) 20 December 1983, The Figure, col. 3 lines 40-42.	13, 14, 33
Y	US, A, 4,872,005 (DELUCA ET AL) 03 October 1989, col. 2 lines 48-56.	15
Y	Motorola ADVISOR Message Receiver Publication, December 1990, Message Time/Date Stamping under Standard Features, see entire document.	15